SECRETS of Home Theater and High Fidelity

A SECRETS Feature Article

Feature Article

THX-Certification: What It Means and How to Use It

January, 2006

Brian Florian

Introduction

THX is almost a quarter century old, and its Consumer Branch has been around since 1990, yet people still do not have a proper understanding of THX. Maybe that's THX's fault, maybe it's ours (the press), maybe it's the sales people's at the local A/V store. Probably, it is a combination of all three, so we're going to at least do our part and tender to you, our readers, this explanatory article.

We will try and dispel the myths, reiterate the truths, and of course give you our slant on the whole thing as well. If you think you know THX, you might be surprised at what you read here. We're in for quite a ride, so let's get comfortable.

In the Beginning . . .

There is now an urban legend that George Lucas walked into a small town movie theater one day and watched Star Wars. The sound system was so poor and so out of alignment that no one could understand the dialogue and the picture was a mess. He decided then and there to found THX, a company which would push out to the world a standards based certification program for movie theaters so that artists could have confidence that their work was being presented as they had crafted it.

True story? In essence at least, if not in fact. Regardless, it's a cute fable which makes for a nice ice breaker.

No, THX grew out of the development of Skywalker Sound, the state of the art post production facility that George Lucas created with the profits from the first Star Wars. Skywalker was to be (and to this day is) the high water mark for facilities of its kind. In developing the the various setups for Skywalker, Tomlinson Holman and the Lucasfilm engineers, through experience and research, defined the ideal standard for mixing rooms, incorporating all the existing international standards set down by SMPTE, ITU, etc. These became the very first THX standards. The year was 1982. When the word got about about just how good things were at Skywalker, the other studios in California asked if their facilities could be upgraded to the same standard. The concept of being "THX-Certified" was born.

Once they started bringing other professional facilities up to their standard, THX realized that what they were doing could be "pushed out" to the local movie theaters, creating an end-to-end consistency in the way movies are crafted and then presented. Everything from the light level on the screen, the background noise level in the room, the quality of the theater and all its equipment, even the quality of the prints and the consistency thereof come under the THX TAP, or Theater Alignment Program. In 1983, the AVCO cinema in Los Angeles was the first theater to receive THX certification.

In the years to come, Tom Holman was not idle. While listening to master tapes of film sound elements

at home on top quality hi-fi gear, he and the sound designers and mixers weren't happy, because the same tapes played in both spaces didn't "translate" accurately. This led Tom to the first set of specifications for THX consumer gear, which we will talk about at length in a moment, and the subsequent launch of the first THX home controller in 1991 (the Technics SH-THX10).

In the years to come, Tom Holman was not idle. While listening to master tapes of film sound elements at home on top quality hi-fi gear, he and the sound designers and mixers weren't happy, because the same tapes played in both spaces didn't "translate" accurately. This led Tom to the first set of specifications for THX consumer gear, which we will talk about at length in a moment, and the subsequent launch of the first THX home controller in 1991 (the Technics SH-THX10).

Myth: "THX DVDs have *THX sound* on them which requires THX equipment to play."

Reality: A THX DVD is one which has been mastered under their supervision to the industries highest standards. There is no proprietary format or content.

Quick sidebar: In the time before DVD I had bought the VHS of James Cameron's *Titanic*. It did not take long to realize the audio on the tape was reversed left to right. I e-mailed THX and within a day I got a phone call asking if they could send FedEX to pick up the tape and drop off a replacement (along with a T-Shirt). Being a THX Digitally Mastered title, they wanted the tape so that they could figure out exactly which duplication machine it was made on and correct it. True story!

THX at Home

THX Home Cinema is fundamentally about one thing: The technically *competent* and *correct* reproduction of a piece of audio/video work. Period. THX is able to achieve this through a very precise, defined specification for hardware which goes well beyond conventional metrics, as well as the incorporation of proprietary technologies and processes that are integral to the system. Their intention is to offer the consumer a system with baseline performance which closely replicates the monitoring environment in the studio. Once that baseline is in place, the consumer can change things any way they like knowing that they can always go back to a baseline that's pretty darn close to the original recording environment.

You may have read the usual diatribe about the goals of THX being:

- Intelligible dialogue
- Pin-point localization
- Enveloping surround
- Accurate frequency response
- Generous dynamics, soft as well as loud
- Accurate coverage ("Every seat is a good seat.")

Yawn! That's all well and good, but frankly that should be the goal of ANY product which makes any sort of "hi-fi" claim (though achieved by few). Performance metrics are obviously the heart and soul of THX certification, but the real benefit of THX for the consumer is exactly how these standards and design elements were arrived at. Holman knew that the source tracks sounded different in a home space, despite him listening to them over absolute state of the art home systems of the time. It would have been easy to say "lets just do the same thing we do at Skywalker sound", but that is utterly unrealistic, even for the very wealthy (and I don't know if this was on George's mind, but technically competent and correct presentation of movies should not have to be the province of millionaires alone).

So in addition to simply drawing on the technologies and specs already developed at SkyWalker for professional facilities, THX Home Cinema did something more: They addressed the REALITIES of the consumer market. They realized that consumers would not put wall-to-wall acoustical treatments in their home, or install an array of 12 surround speakers. They realized that for the most part, home theater is "living room theater". Even so called "dedicated" home theaters have more in common with living rooms than they do with Stage C at Skywalker. As we'll see, everything about a THX piece goes back to this fundamental.

A few words on "Reference Level"

Before we start talking about the pieces and parts, we first need to take a quick refresher on the concept of "Reference Level", as you are going to be hearing that term quite a bit in the coming paragraphs. Simply stated, Reference Level is a standard, known, predictable and reproducible playback volume level. When movie sound tracks are crafted, they are done so on systems which are locked at this level. The sound artist does not play around with a big volume knob when doing his/her work. If the sound artist wants something to be loud, they make that sound loud within the sound track. When they want something to be soft, they make that element soft within the sound track. Movie theaters set their playback level by the exact same rules, so when the movie is shown, you hear EXACTLY what the sound artist heard when they were making the piece. Loud, soft, in-between, it's all there, and no one touches the master volume knob over the course of a two-hour movie.

To achieve THX certification, components must play at this reference level without breaking, distorting, buzzing, rattling or any other distracting effects.

Reference level is by any definition, objective or subjective, quite loud. It basically mirrors the dynamic range of the studio system, which in the case of all movie sound tracks, is 105 dB. Any single channel of the system is calibrated to play 0 dB FSD (the loudest sound the sound track can contain) at 105 dB (115 dB for the LFE channel). While that is really, REALLY loud, its important to remember that there is 105 dB of dynamic range and the artist can put a sound at any level they want. So while a system's volume may be set to reference level, dialogue within the sound track can, and most often is, at a normal, natural level. Reference level, with the dynamic range available, permits a movie to have that normal, natural dialogue, and then suddenly a spectacular, loud car chase without anyone touching the volume control. Every element in the sound track comes out as it should.

Now, having said all that, watching a movie at reference level in a home theater is almost never done. It can be extremely loud to begin with, but the close spaces typical of home theaters make it perceptibly even more so. Reference level is still very important in home theater though for several reasons. Because it is the absolute loudest a sound track should ever be played, its fairly intuitive that its a good idea to have a system that can competently go that loud. It gives you a sort of "safe maximum" volume level, even though you may never push it that high. Even more important though is knowing what volume you are at RELATIVE to reference level because if we go too low, we literally lose the quietest sounds since they are pushed below the audible threshold, surrounds lose their presence, the perceived spectral distribution of the track is altered, and dialogue intelligibility suffers.

The THX Controller

We refer to the THX controller as both dedicated surround sound processor/preamplifiers, and the processing section of integrated receivers.

There are two distinct halves to the certification of a THX Controller. The first is the actual performance metrics, shown in the table at right. As you can see, it goes well beyond any review you've ever read, including our own best. What is absolutely key here is that these are not simply "minimums" a product must meet, but many are actually design considerations. For example, the line level outputs must not only meet a certain voltage capability, but their output voltage must be a certain level *relative* to an input signal, be it analog or digital.

Things like this are important because not only must each THX piece be excellent at what it does, but it must also work in concert with the other pieces to create a synergistic whole. By predetermining the output voltage for a reference level signal, as well as the output impedance, the amplifiers (which we'll talk about in a minute) can be designed and spec'ed in anticipation of that output, and the S/N performance of

Metrics Tested on THX Controllers:
Reference Output Voltage
Voltage Gain
Input Impedance
Gain Control Range
Gain Tracking of the Master Gain Control
Overload Source Voltage
D.C. Bias Current at the Input
Maximum Output Voltage of Low-Level Outputs
Output Source Impedance
Polarity
D.C. Offset at the Output
Frequency Response Deviation
Signal Time Delay
Noise Output Voltage
Input Level Indicator (Clipping Indicator)
Video Path Switching
Video Level
Sync Level
Bar Tilt
Pulse/Bar Ration
K-Factor (K-2T)
Frequency Response Amplitude (0.5 to 4.2 MHz)

the WHOLE system is assured, without any "matching" effort required by you, the end user. THX controllers are a perfect match for THX amplifiers, end of story. You can think of this in terms of dynamic range windows: when they all line up, you get maximum performance all the way through.

The second, somewhat distinct aspect of certification of a THX Controller is the inclusion and implementation of various design features, including the THX Post-Processes. Here we are starting to get into what I was previously saying about THX addressing the realities of home theater.

All THX Controllers include one or more THX modes which are NOT surround sound decoding schemes or codecs. When engaged, the THX modes apply a set of processes or filters to the soundtrack AFTER it has been Pro Logic, Dolby Digital, or DTS decoded.

The most basic THX mode is called simply *"THX Cinema"*. This mode includes:

Group delay (0.5 to 4.2 MHz)
Chroma Gain
Chroma Delay
Differential Gain
Differential Phase
Noise
Video Conversion
Harmonic Distortion and Noise
Difference-Frequency Distortion
Dynamic Range
Digital Data Sampling Rate Support
Input Mode Control and User Interface Design
Input Mode Switching
Automatic Detection of Data Types
Output Modes and Post Processing
Equalization and Tone Controls
Signal Headroom
Bass Management
Filter Characteristics
LFE Channel Level Scaling
Loudspeaker Position Time Synchronization
Auto Calibration
Auto Setup
Output Levels
Dialogue Normalization

Re-Eq, or ReEqualization. Ironically this is the best known, and the single most misunderstood element of a THX processor. Remember we said that Tom Holman found sound tracks sounded different in the home-style rooms? One of the reasons was that they were coming across as too bright, which is a fancy way of saying there is too much treble. Why? The equipment was excellent, high fidelity stuff. The "culprit" if you will, was the room itself. Lacking the extensive acoustical treatments of professional sound and production rooms, high frequency energy is bounced around and sustained. At elevated playback levels (at or close to reference) it gets subjectively worse and you start to squint. Here is the very first example of what THX does to address the realities of the consumer market: THX knew that no one would be talked into turning their family's living room into a sound studio. Instead, Re-Eq simply applies a rational, mild roll-off of the high frequencies. It's that simple.

Everything you have read about movie sound tracks themselves having too much high frequency energy, including what THX's own marketing department has put out there, is inaccurate. The treble is not exaggerated by the sound artist to overcome the perforated screens at the theater (the theater does its own EQ to address that). The tracks do not have too much treble because movie theaters are aligned to something called the X-Curve. We have an entire article on the history of cinema sound system curves which discusses the relevance of the X-Curve, and why it has absolutely nothing to do with why sound tracks sound too bright in a home. Please feel free to digest it when you are done here.

> Another quick sidebar: For many years, my living room was my home theater. As a reviewer, I had the privilege of playing with some very nice amps, preamps, and more speakers than I care to remember, but regardless of the caliber of equipment, movies just sounded *harsh* without a THX controller and Re-Eq. As soon as I created a serious screening room complete with extensive acoustical treatments, I found Re-Eq necessary only at the absolute loudest output levels. Go figure. This is why our Secrets SSP Benchmark specifications require that THX controllers offer the option of turning Re-Eq off independently.

Myth: "THX's *De-Correlation* was made obsolete by the discreet surrounds of Dolby Digital."

Reality: For Dolby Digital and other 5.1

Adaptive De-Correlation / De-Correlation. The THX Home Theater program was launched in 1991 at a time when Dolby Pro Logic, the consumer equivalent of Dolby Stereo, was the only thing going in surround sound. While virtually all surround sound configurations used two surround speakers, Pro Logic decoding yields only one surround channel, meaning both speakers get

formats, *De-Correlation* became *Adaptive De-Correlation,* intelligently applying itself when discreet surrounds contain mono content.

the exact same signal. This can cause the sound to be "in your head" instead of pleasantly surrounding you as it should, or if seated off center, can cause the surround sound to collapse to the speaker nearest you. THX's De-Correlation very subtlety alters the phase and time relationship of the two rear speakers so that they don't sound absolutely identical, maintaining the spacious nature the surrounds are suppose to have.

When Dolby Digital hit the consumer market, De-Correlation was NOT made obsolete by the 5.1 format's two discrete surround channels. Many, many surround sound effects in sound tracks are still input equally to both surround channels so that it fills the surround space, and as such, the system can suffer the same pitfalls as Pro Logic's mono surround channel.

De-Correlation was updated to *Adaptive De-Correlatio*n, which, as the name suggests, adapts to the incoming signal. Content which is identical in both channels undergoes De-Correlation, the rest of the sounds intentionally steered to one side of the other remain as such.

Timbre Matching. A given sound in front of us sounds different if sourced behind us. That's because of the shape of our outer ear and is part of how we can tell where a sound is coming from (the other is the relative amplitude in our two ears). In home theater though, sounds which are panned from the front of the room to the back, or vice versa, can lose continuity because of this auditory reality, since halfway from rear to front the panned sound is actually coming at us from BOTH in front and behind. Timbre Matching applies a generic HRTF (Head Related Transfer Function) to reshape the surround sound speakers' sound so that it is a closer match to what we hear from the front channels, closing the "seam" between the front of the room and the rear.

Also, part of the THX Cinema mode, and indeed any THX mode (we'll talk about some of the others later), is that it "overrides" any superfluous alterations of the program. For example, if bass or treble controls have been engaged, or an alteration made to the level of a speaker (outside of the master calibration), any such "impurities" are zeroed out whenever the THX button is pressed, assuring you that the movie is in fact being presented as it should.

In 1999, a new THX mode was added to the repertoire: *THX Surround EX*. It includes all the aforementioned processes, and simply puts them on top of Dolby Digital Surround EX decoding, so its not really a separate THX mode, but we mention it here because THX actually co-developed Surround EX.

> Dolby Digital Surround EX, as it is called in movie theaters, was jointly developed by Dolby and THX. It applies a Dolby matrix decoder to the two surround channels, and decodes a third channel between them (the *center-surround* or *rear* channel as it is sometimes called) yielding a "6.1" configuration (though the 6th channel is not actually discrete). Soundtracks encoded in this format became available on DVD, and the first consumer systems to decode them were THX units with *THX Surround EX* (the EX decoding later became available on non-THX equipment under the name of *Dolby Digital EX*).

One major design consideration of the THX Controller is the bass management system. While some form of bass management is now common in consumer electronics components, THX designed into their program a very specific bass management system right from the start, back in 1991 when the phrase "bass management" was not even well known. We're going to talk more about it in the speakers section of this article, but suffice it to say for now that the THX Controller has to implement bass management in a very specific way, using a specific set of slopes, to accommodate and make the most of the speaker system. The THX Controller may also provide a bass peak limiter, a feature which allows you to set a maximum signal level sent to the sub. Again, knowing the realities of home theater and that not every situation would permit a subwoofer to be placed in the best spot with maximum loading, THX knew that even a THX sub could be overdriven. The Bass Peak Limiter allows you to "protect" a subwoofer in such situations, taking away the fear you may have of pushing your volume a little closer to reference level. While at one time required by THX, this feature is now an option implemented at the manufacturers discretion because, by and large, powered subwoofers have their own limiter/protection.

Another key element that THX requires for receivers and SSPs is the reference setting for volume control. When a system is calibrated according to the manufacturer's instructions, "0.0 dB" on the volume control

corresponds to reference level playback. In turning the volume down, the volume level is expressed in -dB, or how many dB below reference level you are.

Separate Amplifiers and the Amplifiers in Receivers

Metrics Tested on THX Amplifiers:

It's too easy for people, including us here at Secrets, to say *"get as much power as you can"*, *"you should have at least 100 watts per channel",* and so on. While having more power than you need, even lots more, is not a bad thing and in fact is much preferred by speaker manufacturers (in that more speakers are damaged from underpowered amps driven to clipping, than ones which were fed too much power), the reality is that power, REAL power, is expensive. The question is, how much is needed to drive a reasonably efficient speaker in a reasonably sized room to reference level and still have adequate headroom left over?

THX has done something which, to my knowledge, no one else in the industry has done, at least on the scale which they have done it: They have logged the dynamic content of virtually every piece of finished sound track they can get their hands on (we're talking hundreds of sound tracks here) and from that developed a practical "dynamic" requirement for multi-channel power amplification.

All of the THX amplifier tests use bursts in various combinations at various frequencies, at various lengths of time, repeated cycles and combinations of speaker loads. This enables THX to uniquely qualify an amplifier, particularly a receiver, as capable of playing sound tracks to reference level (given of course a certain speaker efficiency and room size limit).

Make no mistake: THX Ultra power amplifiers tend to be very powerful. We've never seen one with less than 100 watts/channel continuous RMS, full band, all channels driven, BUT because of the "practical sum" THX has defined for themselves, even seemingly modest receivers under $1,000 can get THX Select2 certification and provide a satisfying experience for a lot of people who can't afford a stack of THX Ultra power amps (we'll talk about Select- vs. Ultra-Certification a little later).

Reference Output Voltage
Voltage Gain
Output Current
Output Source Impedance
Overload Restoring Time
Stability with Capacitive Load
Harmonic Distortion and Noise
Modulation Distortion
Difference-Frequency Distortion
Noise Output Voltage
Phase Response
D.C. Offset at the Output
Hum
Crosstalk
Acoustic Noise Level
Mechanical Noise
Input Sensitivity
Input Impedance
Output Impedance
Load Impedance Range
Voltage Output Capability
Current Output Capability
Transient Output Capability
Transient Overload Recovery Time
Asymmetrical Clipping
Frequency Response
Phase Response
Phase Margin
Time
Total Harmonic Distortion
Intermodulation Distortions
SMPTE IM Distortion
IHF IM Distortion
DIM 30 Distortion
Noise
Hum
Radiated Interference
Conducted Interference
Crosstalk

But it's not all about raw power. As we mentioned when talking about the THX Controller, the input and output levels and impedances of everything "THX" are within a certain tolerance so that all pieces "talk" to each other synergistically. One can see from the metrics list above that everything *down to the hum of the power supply transformer* must be in check to be THX certified. Yikes!

Speakers and Subwoofers

Back once again to the realties of the consumer market, and once again knowing that a living room will remain a living room, much of what makes THX speakers unique and special has to do with addressing this fundamental tenet.

Starting with the more pedestrian facets of speaker performance, it almost goes without saying that THX speakers must have no compromise in terms of neutral frequency response, power handling, output capability, and the often overlooked dynamic, or transient, response.

Metrics Tested on THX Speakers:

Axial Frequency Response Analysis
Directional Characteristics
Sensitivity
Impedance
Harmonic Distortion
Low Frequency Cut Off
Phase Angle
Stray Magnetic Flux
Maximum Output Level
Acoustic Noise Level
Polarity

Any good speaker should be able to make such claims. THX speakers are designed as such and can, without hesitation, be driven (by a THX amplifier) to reference level. However, THX speakers go beyond this by designing in certain features and characteristics which put them in a position, as a system, to excel at faithfully reproducing the program in that "living room home theater" we keep talking about.

Main/Front Channel Speakers

THX Speakers have to meet very specific design goals in terms of their radiation pattern: In the horizontal, they must have a very, VERY wide listening window so that everyone across the couch hears good sound. At the same time they must have a limited, or narrow, listening window in the vertical because reflections off the floor and ceiling can smear and distort the sound in the time domain.

Again, back to THX realizing people will not likely acoustically treat their ceilings so that conventional speakers can be used, recently (as of Ultra2) these requirements have changed in terms of emphasis (less on vertical roll-off, more on off-axis linearity), but we'll talk about that when we cover Ultra2 a little later.

The other major design characteristic of a THX speaker is that it is a dedicated satellite speaker which REQUIRES the support of a subwoofer. The THX speaker system therefore is categorically a sub/sat system.

Full-range speakers are nice. I love full-range speakers, but they have no place in a multi-channel sound system if we want to have any chance of realizing a flat, uniform reproduction. Again, this goes back to acoustics: it is very difficult to get a similar low end response from five speakers spread out through a room, or even just three across the front of it, even if all the speakers are identical, because their different physical positions in the room are going to result in different acoustical loading (i.e., the bass response will *not* be the same from speaker to speaker). By summing all the bass in the sound track and sending it to a subwoofer, or set of subwoofers (all getting the same signal), the system's reproduction of bass from each channel will be uniform.

The other benefit of a sub/sat system, known by experts such as Ken Kreisel long before THX and home theater, is dynamics. By asking one amp and speaker to cover the upper audible range (the main speaker) and a completely different one the bottom, both do a better job than either could if it was trying to do the whole shebang.

Myth: "THX speakers only sound good for one person in the room"

Reality: The opposite is true: while THX speakers must have a narrow listening window in the vertical to attenuate reflections from the floor and ceiling, they must simultaneously provide a VERY wide horizontal listening window, ensuring good sound for everyone in the room.

Remember we said bass management was integral to the THX controller, long before a time when it was common in consumer equipment? Now we're getting to the heart of that. These days, all processors and receivers offer bass management, but what slopes do they use? What crossover frequencies are offered? Will it all work with your speakers? If you have a THX Controller with THX speaker, you don't have to worry about this. Your stuff will work together famously because it was designed as such from the ground up.

For you Techies:

The THX crossover consists of an 80 Hz, 4th order Linkwitz/Riley filter alignment, and it was not chosen lightly or without serious consideration. As the crossover frequency increases, it becomes harder to blend the subwoofer with a satellite, and the subwoofer becomes more difficult to audibly "hide". At the same time, as the crossover frequency increases, distortion from the satellite decreases, the total dynamic range increases, and loading the room for the flattest response becomes much easier. The logic of the 80 Hz crossover point is that it's high enough to ease demands on the speakers and amplifier, but low enough to make the whole setup work without a tremendous headache. The 4th order (24dB/octave roll-off, 6dB/octave/pole) Linkwitz/Riley alignment not only offers a steep slope, but one that immediately transitions to that slope, maximizing the benefits of that slope near the crossover point. The high-pass side minimizes excursion and power requirements, while the low-pass minimizes more localizable content at higher frequencies.

To correctly achieve this, THX satellite speakers are sealed systems with an 80 Hz –3 dB low frequency cutoff (preferably with a Qtc of 0.71). The electronic high-pass filter applied to them is an 80 Hz, 2nd order (12dB/octave) Butterworth alignment. The speaker and the filter sum to a 4th order Linkwitz/Riley roll-off which matches the electronic filter applied to the subwoofer, and an excellent crossover is achieved.

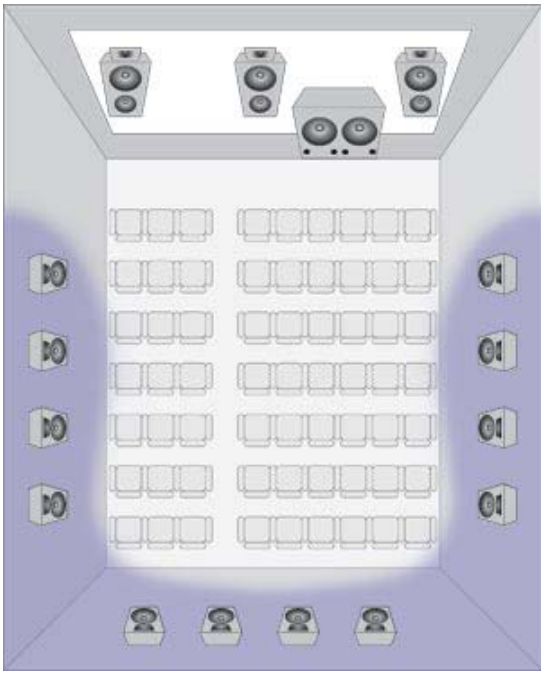
Surround Channel Speakers

The surround channels in movie theaters are reproduced by arrays of speakers, anywhere from four to sixteen speakers on either side and the same again across the back. What is the best way to reproduce that surround sound effect at home? The answer would be to use twelve or more surround speakers of course! THX knew that no one would even entertain such a suggestion so for their surround speakers they mandate a dipole design.

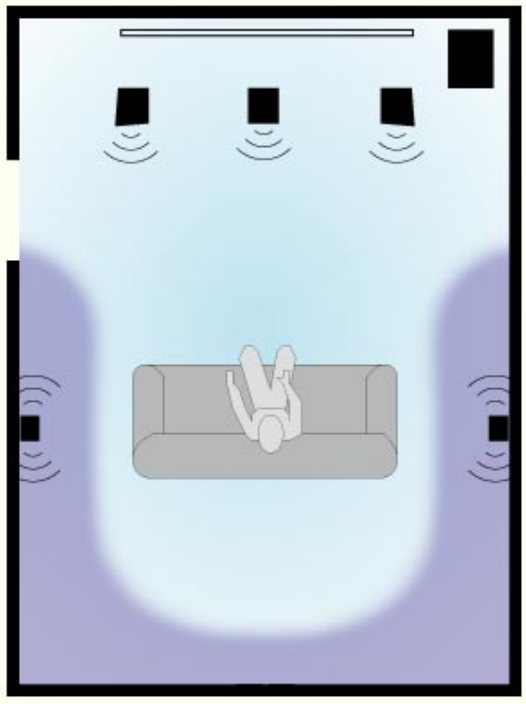
Myth: "Di-Pole surround speakers were used because of Dolby Pro Logic's mono surround channel and are obsolete with Dolby Digital 5.1."

Reality: Di-poles are used to emulate the multi-speaker arrays of movie theaters. It is *Adaptive De-Correlation* (see THX Controller section above) which addresses mono surround channel issues.

A dipole, or dipolar speaker is one which fires sound from two opposing sides, or poles, where each pole is out of phase with the other (meaning that while one side is moving outward, the other is moving inward). In a home theater, they are generally placed to the side of the main listening area with the poles firing to the front and back of the room, never directly at the listener. The result is that the sound bounces off the walls of the room, successfully *emulating* the speaker arrays of the movie theater.



Movie theaters and large dubbing stages use speaker arrays for uniform, enveloping surround sound.



Dipoles in a home theater do an admiral job of emulating that sound field using just two properly placed speakers.

THX dipoles must meet a strict requirement of flat total power output, which means the sum of the sound coming spherically from all around the speaker must be smooth, as opposed to the sound coming from just one of the poles. This is not easy for a designer to do, and there are plenty of examples of poorly designed dipoles (none of which are THX-Certified).

In general no one will deny that dipoles do an admirable job of emulating the multi-speaker arrays of movie theaters, but many a journalist has gone on record as saying they are not suitable for multi-channel music and that monopole (a.k.a. conventional) speakers must be used.

Research done by Tom Holman in 1986 (involving both technically savvy audio engineers as well as laypeople) revealed that while some sound engineers preferred mono-poles in certain situations only for their ability to "expose" defects such as pops and dropouts, when it comes to actually listening, all persons showed a clear preference for a diffuse ambient surround sound field when the test involved properly designed dipoles level matched to the monopoles they were being compared to. The "bad-rap" dipoles get is often due to evaluations clouded by the use of improperly designed dipoles and a failure to level-match them with monopole counterparts.

There are *many* ways of getting diffuse sound, including strategically positioned and angled monopoles, but dipoles are simply the most practical solution for a consumer (once again, THX is dealing with the realities of the market).

Myth: "THX Surround speakers are ok for movies but not music"

Reality: THX Surround speakers, with their flat total power response, provide excellent, pleasing results for BOTH movies and music.

Ultimately, the argument of monopole vs. dipole surrounds is one of inevitable compromise, with THX and others selecting the dipoles as the preferable of the two. These days, THX certifies mono, di and bipole surrounds, recognizing that each has its appropriate use. To achieve that elusive balance of envelopment with some directionality of special effects or game sounds in wildly different rooms, it's necessary to choose the design that works best. THX still puts dipoles first as great problem solvers in many typical rooms, but they acknowledge that other designs have their uses.

Subwoofers

THX-Certified subwoofers embody the usual tenets of bass, which is both high in output and low in distortion. Back to Reference Level, a THX subwoofer has to be able to reproduce the bass from all the channels of a sound track at Reference Level (within a room size limitation) without distress or calling undue attention to itself. Beyond that, like regular power amplifiers, the built-in amplifiers of THX subwoofers must conform to an I/O spec that matches the THX controller. In particular, voltage levels are much higher than for the other line-level signals, several times higher in fact! This gives the subwoofer the 20 dB headroom it needs over any other channel (because it carries the bass from all channels, plus the LFE channel, all summed together).

In terms of depth, THX subwoofers are traditionally anechoically flat to 35 Hz with a shallow roll-off thereafter, allowing room-gain to make up the difference for a perceived flat in-room response. That has changed somewhat with Ultra2, which we'll get to in a moment.

Projection Screens and Other Things

THX also has a specification and certification for perforated, acoustically transparent screens, which obviously involves ensuring they really are acoustically transparent, or at least that the loss incurred is predictable and uniform such that it can be easily compensated for. Light loss must also be minimized.

Although of little interest now, THX at one time had certification of LaserDisc players.

Rane and AudioControl had THX-Certified equalizers, which are still prized pieces.

THX Select vs. Ultra

In 1999, THX launched THX Select, and renamed what had previously been called just THX to THX Ultra.

Whereas THX/THX Ultra was specified and designed for rooms "up to" 3000 ft3, THX Select took that requirement down to 2000 ft3. Both the requirements of the amplification and the output of the speakers were scaled back appropriately, placing THX in the hands of a whole new audience who could not have otherwise afforded it.

When it comes to amplification, continuous output tests are run on up to one, four, and five channels (simultaneously) of an Ultra product, but only one at a time on Select. With all products, the dynamic amplifier tests are done on up to all available channels. Ultra amplifiers must be stable on all channels to 3.2 ohms and swing an 18A peak, while Select products must be stable into 4 ohms (front channel) and 8 ohms (surrounds), and swing peaks of 12.5A and 6.2A respectively.

So, right off the bat, Select amplifiers have a lower bar to reach, but ultimately in meeting it, they will still cleanly drive any reasonably designed speaker to reference level in a Select-size room. What we are talking about here is the idea that the lower powered equipment can get a THX certification that will assure consumers that the really affordable stuff has met certain standards like the high-end equipment.

The THX Controller section features are no different between Select and Ultra, which is why you'll never see a Select preamp/processor (SSP), only Select Receivers.

THX Select speakers, other than having reduced output requirements as compared to Ultra, do not have the same requirement for a narrow vertical listening window, because in a Select-size room you are apt to be close to the speakers and floor/ceiling reflections are that much less of an issue. While THX Select surround speakers are still recommended to be dipole in design, conventional monopole designs are permitted for a few reasons, the main being that dipoles are, by their nature, expensive (having twice as many drivers as a conventional monopole), which goes against Select's mandate for a more affordable system.

Select subwoofers of course have reduced output requirements as compared to Ultra.

Ultra 2: The Second Age

In 2001 THX revamped their Ultra program into Ultra2.

Ultra 2 Processing

One of the catalysts of the revamp was the enthusiastic consumer embrace of *THX Surround EX* and the 7.1 speaker layout that it implies, but Surround EX decoding only "works" well if the sound track was implicitly encoded for it, otherwise the surround sound filed tends to collapse to the center surrounds. At the same time, multi-channel music was becoming more of a presence in the market, and speaker arrangements for music vs. movies were at odds with each other, with movies favoring a very diffuse sound field produced from the sides, and music favoring more in-your-face surround, with the source being more "behind" you.

With Ultra2, THX came up with a single system and speaker configuration which would work for everything.

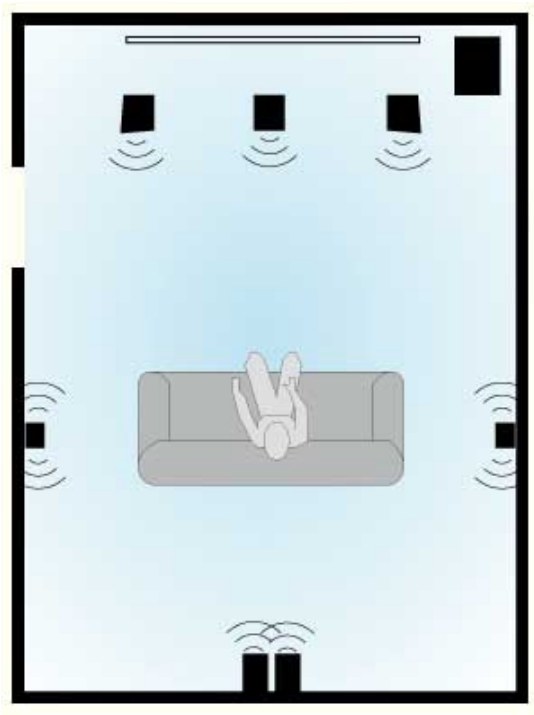
Whereas THX Surround EX simply called for two more surround speakers at the back of the room for the then new sixth channel, Ultra2 replaced them with a pair of monopole speakers specifically placed right next to each other. Somewhat like the way two-channel stereo can "position" sounds between two speakers, THX with their new process they call ASA, or **A**dvanced **S**peaker **A**rray, is able to "position" virtual surround speakers between the side surround speaker and the corresponding rear speaker (it's not really that simple, but it is the best way to visualize it). So while Ultra2 controllers still offer *THX Cinema* and *THX Surround EX* modes, THX introduced three new THX modes with Ultra2 which use ASA:

THX Ultra2 Cinema. This mode is identical to THX Cinema, except it does a "soft EX decoding", giving us some output from the rear, but does not allow the sound to collapse there. Surround sound predominantly comes from the side dipole speakers.

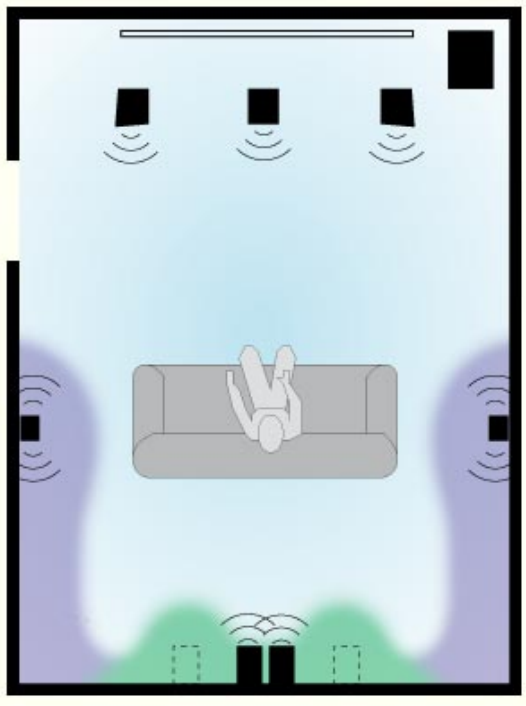
THX Music. This mode differs from the above in two ways. First, using ASA, the surrounds are virtually positioned between the side and corresponding rear speaker, a position usually favored by multi-channel

music setups. This mode also disengages Re-Eq because music tends to be enjoyed at a lower median level than movies, and as such does not need it.

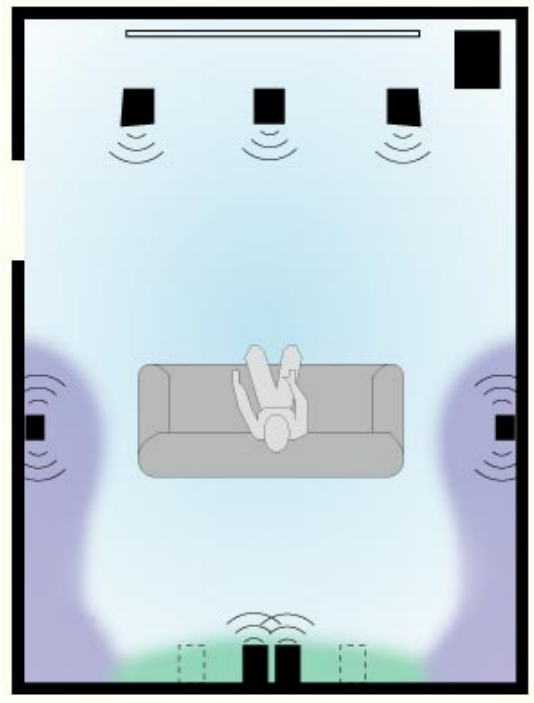
THX Game. This mode basically puts all surround speakers on full duty, giving you a very lively, "exciting" sound experience which is what people want when playing an active video game.



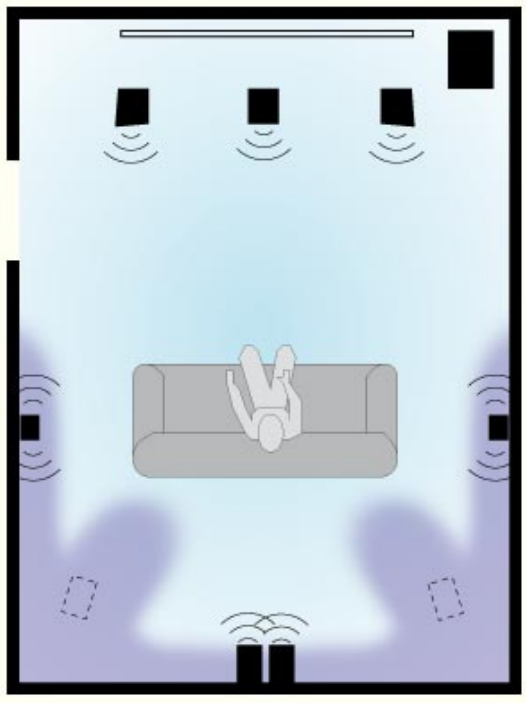
The THX Ultra2 Layout



For THX Surround EX, ASA places "virtual" speakers in the requisite position.



For Ultra2 Cinema, ASA "softens" the rear channel, keeping it active, while eliminating the "collapse" associated with Surround EX decoding of non-EX encoded material.



For Ultra2 Music, ASA places "virtual" speakers in the location favored by multi-channel music enthusiasts, while maintaining an overall spacious surround space.

Its important to note that the Ultra2 controller has a setting for the distance between the two rear speakers, the default being <1ft as depicted above, yielding the most spacious sound field. The alternate setting of 1-4 ft can be used to "favor" the music playback mode. By moving the physical rear speakers apart, there is less of a "virtual speaker", with more of the surround sound in Music mode coming from the monopole rear speakers.

Ultra2 Hardware

THX Ultra2 also raised the bar for speaker performance. While output, sensitivity, and distortion requirements stayed the same, off-axis performance requirements changed dramatically. THX also changed how they measure the performance.

Smoothness of off-axis performance is now emphasized rather than *attenuation* as called for in Ultra. Recent research makes it clear that speakers with off-axis performance which is completely free of peaks and dips in amplitude response sound better that those with peaks and dips (even if attenuated). If a room has unacceptably strong ceiling and floor reflections, it is possible to correct that with acoustical treatments (something more and more consumers are willing to do), but poor off-axis linearity is something you can't fix after the fact.

They've also broken up the linearity requirement with Ultra2 into three bands of the audible frequency spectrum: Low, mid, and high. The ± dB window is quite tight in the mid-band, with greater variation allowed for the low and high. This requires that a speaker be quite accurate in the critical mid-band while still giving the designer enough latitude to keep their company's signature "voicing". Frankly, we find this last item a little disappointing, since we are somewhat opposed to the notion that a speaker should ever have any sort of unique "character". THX's answer is that they realize no speaker is absolutely 100% perfect in this respect, and their banding of the spectrum simply forces a manufacturer to concentrate the greatest effort on the band that matters most.

In addition, subwoofers now need to be anechoically flat to 20 Hz. THX did this because their research shows it give them a better match with the rolled-off energy from the satellite speaker. Because these new subs may get shoved into a corner and end up with TOO MUCH at the bottom end, THX Ultra2 controllers include a Boundary Gain Compensation which, when selected during set-up, rolls-off the bottom end of the subwoofer signal to compensate if an Ultra2 sub is getting too much help from the room itself.

Select2

In 2005, THX Select was revamped to Select2. Intuitively, Select2 inherits from Ultra2 the ASA (Advanced Speaker Array) along with the modes that use it: *THX Select2 Cinema*, *THX Music*, and *THX Game*. As such, support for 7.1 speaker configuration is no longer optional as it was with Select (products can include only five channels of amplification, but they must provide the full 7.1 line-level output).

The S/N (signal to noise) requirement was increased 9 dB with Select2. THX tells us that while, at first, some manufacturers grumbled at the extra design work that would take, all certified products have managed to meet the new requirement.

Some Things We're Not Crazy About

In 1998, THX launched certification for DVD Players, and we were a little disappointed to say the least. While on paper their goals for DVD Player design are first rate (see metrics list at right), they quickly brought their testing and certification integrity to question with the very first Certified DVD Players such as the Pionner DV-09. More recent offerings from the likes of Denon fair much better, but we would be remiss if we were to not mention this "sour" launch and there are still models which fall well short of our own

Metrics Tested on THX DVD Players:

Video Level
Sync Level
Bar Tilt
2T K Factor
Pulse/Bar Ratio
Sin x/x Response
Sin x/x Group Delay
Chroma Level

Benchmark.

Another THX product which leaves us scratching our heads is cables, and that's NOT a reflection on THX. It's no secret cables are a high margin item, but the THX cables we've seen take it to a whole new level. It's important to remember that THX doesn't tell people how to price or market their products. If a cable or wire passes the signal for which it is intended with acceptable integrity, THX will give it a license to use their name. They can't help it if the licensee goes on to position and price the product as something it is not. In fact, some of the THX interconnects we've played with employ ridiculously tight RCAs which only give a false impression of superior connection while introducing the risk of breaking your equipment from the force required to plug or unplug them.

Composite and Y/C Chroma Delay
Chroma Differential Gain
Chroma Differential Phase
Burst Amplitude Differential
Flesh Tone Phase Error
Luminance Linearity
AM Chroma Noise
PM Chroma Noise
Chroma Correlated Noise (IM)
Chroma Burst Frequency Leakage in Y
Chroma Burst Frequency
H Sync Timing

One nice thing about THX and cables, however, and indeed the I/O jacks on THX equipment, is that they have a comprehensive color coding scheme. Unfortunately, THX has not pushed it as hard as they should have, and most products either fail to use the color coding scheme, or don't use it comprehensively. Another nice THX cable thing that THX let go of was their standard for a single DB-25 multi-channel connection. My 10 year old Rotel five-channel THX amplifier has this input. If I had a THX controller with the corresponding output, I would have only one cable between them, not five. THX tells us it fell by the wayside because no one was willing to put it on their product for fear of it being seen (incorrectly) as a "degraded signal path".

As far as THX DVD titles, every one we've come across has *exquisite* sound, but on occasion perfection in the video quality is debatable. It might be excellent, but not exquisite. Some titles exhibit the all too common halo/ringing artifact, but further investigation is warranted before we pass final judgment (it has been suggested that, at least in the case of Lucasfilm's own *Star Wars Episode I*, it was an artifact of the green screen process which "crept through" to the hi-def master).

Myth: "THX equipment only works with other THX equipment."

Reality: Any THX piece can be used with non-THX equipment, though in certain situations you may end up loosing some of the benefits. For example, using THX speakers with a non-THX crossover will result in a less than perfect subwoofer/speaker splice.

THX-like Settings

You can get some of the THX benefits without actually having THX-certified equipment.

Many non-THX receivers are using the same combination of bass management crossover slopes as THX, and simply using a THX speaker set, or a non-THX set with the same FR alignment, will net you the same perfect crossover. Although difficult to find and identify, there *are* properly designed dipole speakers which are not THX-Certified (Paradigm models come to mind).

There are many examples of excellent, non-THX high power amplifiers which will fit right in with the rest of the THX pieces, though if you are picky, you'll want to do your homework to make sure it mates perfectly with the rest of your stuff.

We've already mentioned not worrying about THX-Certified cables. And, you can look at our own DVD Player Benchmark to find out what you need to know when picking a player.

You could (and should!) acoustically treat your room, and as a result be able to accommodate a wider variety of speakers, maybe even negate the benefits of Re-Eq, but even in that situation, THX equipment can't hurt, so you might as well put some on your shopping list.

The Certification Process

As romantic as it sounds, manufacturers do not simply submit a product to THX for testing and then get a yea or nay. A THX product starts with the manufacturer purchasing the expensive and **confidential** THX

Design Manual for the product in question. THX products are *designed* to be THX products. The manufacturer knows what they have to do from square one. Once they have a working sample, it is sent to THX where it is tested, for a fee, and either checks out and a license granted, or it is sent back with a report on what needs to be addressed. THX tells us that they have yet to receive a product which got everything 100% right on the first try.

Licensees then pay a small per-unit license fee for the manufactured product.

I hope everyone can appreciate why, to this day, the particulars of THX's criteria are not public. They are a business like any other and they need to protect their intellectual property. If everything was out in the open, people could just say, "It meets or beats the THX criteria", and THX would get nothing. They'd fold, and we'd never get all the benefits they've brought this industry over the years.

Myth: "THX restricts manufacturers in terms of their design creativity."

Reality: Nothing could be further from the truth! See text at left.

When asked why their product is not THX certified, some manufacturers have told us its because they "wanted to do things THX does not allow". In terms of speakers, there is indeed not a whole lot of latitude (no full-range models for example), but when it comes to electronics, that's nonsense. THX requires that a piece perform to their spec (or exceed it) and that it do what it is supposed to do when the THX mode is engaged. Manufacturers are free to offer exotic decoding schemes, try innovative things like room EQ (such as the Audyssey system in some recent THX receivers), or offer crossover options other than the standard THX (because not every customer is going to have THX speakers). Lack of THX certification in higher-end electronics (where cost is *supposed* to be no object) *may* be an indication that the manufacturer is not willing to make a competent product, or that they just don't feel their customer is interested in certification.

Nick Platsis from Anthem Audio Video:

> *"The THX Ultra2 spec has tougher standards compared to the other licensing bodies, for example higher output swings are required, especially for the subwoofer channel. On the video side, no one else tests it. It's good that someone does, for example some manufacturers may take the bandwidth of a video switch and try to pass that on as the bandwidth of the whole circuit from input jack to output jack. Regardless, it's not difficult to meet any of these standards unless attempting to do it on the cheap or there's an element of laziness somewhere.*
>
> *The challenge is integrating every single option that THX, Dolby, and DTS have to offer while maintaining user friendly operation and preventing conflicts between the various requirements. Then, when more processing options appear on the scene, it starts all over. Luckily, the people at THX are great to work with."*

Other Areas of Interest

In recent years, THX has branched out into other markets as well as continually revitalizing existing ones.

On the professional side, THX has implemented PM3, their **P**rofessional **M**ulti-channel **M**ixing and **M**onitoring program.

THX has also become active in the PC Computer market. While the THX Computer was something of a flop, THX PC Speakers are very well respected. There isn't really an industry standard for PC sound like their is for movie sound, so what THX is doing with PC speakers is basically saying that at a given price, a product is as good as it can be, basically giving you some assurance you're not being ripped off, and it takes away your need to try and decipher specs (which in the PC Speaker market are practically useless).

Perhaps more interestingly, THX has gotten involved with computer/PC Game development. The production values of computer and console games have risen tremendously in recent years, in some cases rivaling Hollywood, but the industry at large has grown up largely without the benefits of standards. It has taken THX to come in and infuse the industry with the concept of consistent and

performance-oriented presentation. For the first time, the person doing the raw art, sound bites, 3D environments, or what have you, can be assured that the effort they put into their work will be realized right to the end because everybody's workstations, environments, and equipment are all set up to the same consistent standards. Room acoustics, background noise, room lighting, every piece of audio and video equipment, all must meet certain THX performance requirements.

THX has also been contracted to design Car Audio systems for Lincoln. The pieces and bits are manufactured to THX design and spec by Ford sub-contractors. They have a full time staff in Detroit to handle this project with several THX home office engineers working on auto projects as needed.

Looking Forward

We are assured that THX is very busy with new projects, and there are aspects of the industry we know could use their help.

In the works is a program which makes it possible to have a home theater itself THX certified (as opposed to just the equipment in it), which although the province of only the most wealthy, is an awfully cool notion. If you have a spare $250,000 or so, a THX Reference theater can be yours in about 12 months. Standard theaters should come in in the $50,000 range and will be possible in about 18 months. These theaters require THX gear (d'uh!) and must be built to THX-approved plans and tested to meet THX performance minimums for both audio and video. The big difference between *reference* and *standard* will be in video requirements and sound isolation, both of which get quite expensive quite fast.

Conclusions

I would be remiss if anyone came away from this essay with the impression that Secrets endorses everything THX does or that we feel anything non-THX is intrinsically inferior.

I do hope we've given you a better understanding of THX, enabling you to decide if THX is for you. I cannot stress enough that it never "hurts" for a piece to be THX-certified, except that it sometime may costs a little more. Shopping for a system "from scratch" is an excellent time to consider THX because virtually all of the guesswork as to what will work with what and how it will work together has been taken care of for you. At the same time, there is nothing stopping you from integrating a couple THX pieces, the ones that make the most sense to you, into an existing system that has non-THX-Certified components.

THX guarantees a lot of very useful features, and if you get a THX system, then simply plug everything in and press Play, you're going to get results that are pretty close to acceptable. If you actually then further calibrate and position speakers properly, it'll almost certainly be excellent. Buying non-THX, most importantly, means that you have far less of an idea about what you're getting without some homework.

- Brian Florian -

I would like the thank John Dahl of THX for his time and assistance in the writing of this article.

© Copyright 2006 Secrets of Home Theater & High Fidelity

http://www.hometheaterhifi.com/volume_13_1/feature-article-thx-1-2006-part-1.html